UNIVERSITY OF CALCUTTA

SYLLABI

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THREE-YEAR HONOURS AND GENERAL
DEGREE COURSES OF STUDIES

PHYSIOLOGY

2010

w.e.f. 2010-11

HONOURS

PART –I
Theoretical

Paper – I (F.M. 100)

Unit -01 : 50 Marks	**Lectures required** (Each period of 45 minutes duration)
1. Cell Biology I	08
2. Cell Biology II	12
3. Biophysics	16
4. Enzyme	10
5. Digestive System	14

Unit- 02 : 50 Marks

1. Biochemistry-I	10
2. Biochemistry-II	12
3. Vitamins and Minerals	14
4. Muscle Physiology	12
5. Nerve Physiology	12

Paper – II A: (F.M. 50)

Unit – 03 : 50 Marks	**Lectures required** (Each period of 45 minutes duration)
1. Blood	14
2. Cardiovascular System I	14
3. Cardiovascular System II	10
4. Body Fluids and Regional Circulation	08
5. Respiratory System	14

Paper – II B Practical (F.M. 50)
(One practical class is of 3 periods) **Classes required 50**
(Each period of 45 minutes duration)
Unit – 04 : 50 Marks

1. Histology	
Haematological Experiments	15 marks
Permanent slide identification	15 marks
2. Biochemistry	
Qualitative Experiments	10 marks
3. *Viva – Voce*	5 marks
4. Laboratory Note Books	5 marks

PART – II

Theoretical

Paper – III (F.M. 100)

Unit -05 : 50 Marks **Lectures required**

(Each period of 45 minutes duration)

1.	Nervous System I	10
2.	Nervous System II	14
3.	Nervous System III	14
4.	Nervous System IV	14
5.	Molecular neurobiology	08

Unit – 06 : 50 Marks

1.	Instrumentation	12
2.	Renal Physiology	14
3.	Sensory Receptors, Olfaction & Gustation	10
4	Audition	10
5.	Vision	14

Paper – IV A (F.M. 50)

Unit – 07 50 Marks **Lectures required**

(Each period of 45 minutes duration)

1.	Biological Oxidation and Carbohydrate Metabolism	12
2.	Amino acids and Purine & Pyrimidine Metabolism	10
3.	Lipid Metabolism and Reactive Oxygen Species	12
4.	Methodologies	10
5.	Molecular Biology	16

Practical

Paper – IVB (F.M. 50)

(One Practical class is of 3 periods) **Classes required 50**

(Each period of 45 minutes duration)

Unit – 08 : 50 Marks

1.	Histology Fresh Tissue Experiments	10 marks
2.	Biochemistry Quantitative Estimations	15 marks
3.	Experimental Physiology Amphibian skeletal muscle experiments Amphibian unperfused heart experiments	15 marks
4.	*Viva – Voce*	5 marks
5.	Laboratory Note Books	5 marks

PART –III
Theoretical

Paper –V (F.M. 100)

Unit – 09 : 50 Marks

	Lectures required (Each period of 45 minutes duration)
1. General Endocrinolgy I	14
2. General Endocrinolgy II	12
3. General Endocrinolgy III	12
4. General Endocrinolgy IV	14
5. Chronobiology	08

Unit – 10 : 50 Marks

	Lectures required (Each period of 45 minutes duration)
1. Reproductive Physiology I	14
2. Reproductive Physiology II	14
3. Developmental Biology	12
4. Nutrition and Dietetics	12
5. Social Physiology	08

Paper VI (F.M. 100)

Unit- 11 : 50 Marks

	Lectures required (Each period of 45 minutes duration)
1. Work Physiology and Ergonomics	15
2. Sports Physiology	15
3. Skin and Body Temperature Regulation	10
4. Human and Environment I	10
5. Human and Environment II	10

Unit - 12 : 50 Marks

1. Microbiology I	12
2. Microbiology II	10
3. Immunology	14
4. Pharmacology	12
5. Biostatistics	12

Practical

Paper – VII (F.M.100)
(One Practical class is of 3 periods) **Classes Required 70**
(Each period of 45 minutes duration)

Unit - 13

1.	Biochemistry	40 Marks
2.	Experimental Physiology	25 Marks
3.	Microbiology & Biochemical Technique	10 Marks
4.	*Viva – Voce*	15 Marks
5.	Laboratory Note Books	10 marks

Paper VIII (F.M. 100)
(One Practical class is of 3 periods) **Classes Required 70**
(Each period of 45 minutes duration)
Unit - 14

1.	Histology	15 Marks
2.	Experimental Physiology	20 Marks
3.	Experiments on Work Physiology and Ergonomics using human subjects	15 Marks
4.	Biostatistics	10 Marks
5.	Social Physiology	
	Diet Survey	08 Marks
	Field Study Record	07 Marks
6.	*Viva – Voce*	15 Marks
7.	Laboratory Note Books	10 Marks

PART-I

Theoretical

PAPER – I (F.M. 100)

UNIT : 01 (50 Marks)

1. Cell Biology I :

Electron microscopic structure and functions of eukaryotic endoplasmic reticuli, ribosome, golgi bodies, mitochondria, lysosomes, peroxisomes cytoskeletal elements, centrosomes and plasma membrane and subcellular membrane. Ion pores, ion pumps, ion channels, ionophores, passive transport – facilitated diffusion, uniport, symport, antiport. Active transport.Artificial membrane –liposome and erythrocyte ghost. Basic idea of tight junctions, gap junctions and cell adhesion molecules.

(08 lectures)

2. Cell Biology II :

(a) Genetics :

Chromosome structure – morphology. Chromosomal DNA packaging – nucleosomes and higher levels of organization of chromatin. Euchromatin and heterochromatin. Human genome and its characteristics. Nuclear and mitochondrial DNA. Cell cycle – events and regulatory role of cyclin. Elementary idea of apoptosis.

(b) Cell Signalling :

Cell surface receptor proteins – ion channel coupled, G-protein coupled and enzyme-coupled. Intracellular messengers – cAMP, cGMP, IP3, DAG, Protein kinases, Ca^{2+}, CO, NO. Signal transduction pathways – Phosphatidylinositides, MAP kinase, JAK-STAT, SMAD. **(12 lectures)**

3. Biophysics :

Diffusion, surface tension and viscosity – their characteristics, factors influencing and biological applications. Osmosis: osmotic pressure – laws, determination – freezing point depression method and biological applications. Protolysis of water, pH, acid-base neutralization curves, Buffer action: Henderson-Hasselbalch equation. Regulation of pH by blood buffers. Determination of pH – Basic concept of indicators, principle of pH meter- hydrogen electrode and glass electrode. Colloids : Classification, properties – optical, electrical, electrokinetic. Biological importance of colloids. Dialysis and ultrafiltration. Gibbs-Donnan membrane equilibrium. Thermodynamics : Type of surroundings and systems. First Law– Internal energy, enthalpy. Second Law – Entropy, Free energy change, Endergonic and Exergonic reactions, Reversible and Irreversible processes, Equilibrium constant. Physiological steady-state, Living body as a thermodynamic system. **(16 lectures)**

4. Enzymes :

Classification- EC nomenclature, Concept of apoenzyme, holoenzyme, coenzyme, cofactors and prosthetic group. Mechanism of enzyme action : Activation energy, Enzyme-substrate complex, Transition state and Products. Models of enzyme-substrate interactions. Specificity of enzymes. Concept of initial rate, maximum velocity and steady-state kinetics. Michaelis constant, Michaelis-Menten equation, Graphical representation of hyperbolic kinetics– Lineweaver-Burk plot. Significance of K_m and V_{max}. Factors influencing enzyme-catalyzed reactions : substrate concentration, enzyme concentration, pH, temperature. Competitive, non-competitive and uncompetitive inhibitions. Regulation of enzyme activities – covalent modifications, allosteric modifications – Sigmoid kinetics and Hill equation : K- and M- series, Feed-back inhibition. Rate-limiting enzymes. Isozymes, Ribozymes and Abzymes.

(10 Lectures)

5. Digestive System :

Anatomy and histology of alimentary canal. Digestive glands – histological structures of salivary glands, pancreas, liver. Deglutition. Movements of alimentary canal and their regulations. Composition, functions and regulation of the secretion of salivary, gastric, pancreatic and intestinal juices and bile. Synthesis of Bile acids. Enterohepatic circulation. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. Defecation. Feces. GALT. Basic concepts of Peptic Ulcer, Jaundice and Gall-stones. **(14 Lectures)**

UNIT :02 (50 MARKS)

1. Biochemistry I :

Carbohydrates : Definition and classification.

Monosaccharides – Classification, structure, stereoisomerism, optical isomerism, optical activity, epimerism. Cyclic structures- Pyranose and furanose forms, anomerism, mutarotation and its mechanism. Chemical reactions of monosaccharides (Glucose & Fructose) –– Reactions with concentrated mineral acids, alkali, phenylhydrazine and their biochemical importance. Derivatives of monosaccharides ––––Amino sugars, deoxy sugars, sugar alcohols, sugar acids, sugar esters, their biochemical and physiological importance.

Disaccharides – Maltose, Lactose and Sucrose : Structure, Occurrence and Physiological importance.

Polysaccharides – Starch, Glycogen, Dextrin, Cellulose, Glycosaminoglycans, Glycoproteins, Sialic acids, Lectins, Blood group polysaccharides.

Lipids : Definition and classification. Fatty acids ––––– Classification, systemic nomenclature and structure.Mono-, Di- and Triglycerides. Properties of Fat and Fatty acids —Hydrolysis, Saponification, Saponification number, Iodine number, Acetylation - Acetyl number. Hydrogenation, Rancidity-Acid number, Reichert-Meissl number. Cis-trans isomerism. Eicosanoids, Phospholipids, Glycolipids, Sphingolipids, Cholesterol & its ester –– their structure and physiological importance. Lipoproteins —Structure and classification. **(10 Lectures)**

2. Biochemistry II :

Amino acids : Classification, Structure, Nomenclature and Optical properties. Protonic equilibria of amino acids – Zwitterions, Isoelectric point, titration curve of amino acids. Reactions with ninhydrin and formaldehyde.

Peptides and Proteins : Structure and properties of peptide bonds — Phi and Psi angles. Reactions with Sanger's and Edman's reagent. Biuret reaction. Different levels of protein structure — Primary, Secondary (α-helix and β-pleated sheet), Tertiary and Quarternary. Forces stabilizing the structures. Denaturation and Renaturation.

Purine and Pyrimidine : Structure, nomenclature and tautomerism.

Nucleic acids : Nucleosides and Nucleotides ––– structure. Polynucleotides. DNA double helix —– Primary, Secondary and Tertiary structure. A-DNA, B-DNA and Z-DNA. RNA ––– Structure and types. Denaturation and annealing of DNA. Hyperchromicity, melting temperature and half $C_o t$ value. **(12 Lectures)**

3. Vitamins and Minerals :

Vitamins: Thiamin, Riboflavin, Niacin, Pyridoxine, Pantothenic Acid, Biotin, Cyanocobalamin, Folic Acid, Ascorbic Acid, Inositol. Vitamins A, D, E and K. Chemistry, dietary sources, daily requirements, biochemical roles and functions, deficiency symptoms, hypervitaminosis, antivitamins. Minerals: Sources, biological functions, metabolism and regulation of sodium, potassium, calcium, phosphorus, iron, zinc, iodine and fluoride. **(14 Lectures)**

4. Muscle Physiology :

Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles. The sarcotubular system. Red and white striated muscle fibers. Single-unit and multi-unit smooth muscle. Muscle groups : antagonists and agonists. Properties of skeletal muscle: excitability, contractility, all or none law, summation of stimuli, summation of contractions, effects of repeated stimuli, genesis of tetanus, onset of fatigue, refractory period, tonicity, conductivity, extensibility and elasticity. Optimal load, optimal length of fibers. Muscle proteins. Mechanism of skeletal and smooth muscle contraction and relaxation : Excitation-contraction coupling. Dihydropyridine receptors & Ryanodine receptors. Mechanical components of muscle. Isometric and isotonic contractions – muscle length, tension and velocity relationships. Chemical, thermal and electrical changes in skeletal muscle during contraction and relaxation. Electromyography. **(12 Lectures)**

5. Nerve Physiology:

Structure, classification and functions of neurons and neuroglias. Cytoskeletal elements and axoplasmic flow. Myelinogenesis. The resting membrane potential. The action potential. Electrotonic potentials. Current of injury. Propagation of nerve impulse in different types of nerve fibers. Compound action potentials. Properties of nerve fibers : excitability, conductivity, all or none law, accommodation, adaptation, summation, refractory period, indefatigability. Chronaxie, rheobase and utilization time. Synapses : types, structure, synaptic transmission of the impulse, synaptic potentials, neurotransmitters, cotransmitters, neuromodulators. The neuromuscular junction : structure, transmission, end-plate potential, MEPP, post-tetanic potentiation. Motor unit. Motor point. Injury to peripheral nerves – degeneration and regeneration in nerve fiber, changes in the nerve cell body, transneuronal degeneration, changes in receptors and motor end-plates, denervation hypersensitivity. Thermal changes of nerve during activity. Nerve growth factors. **(12 Lectures)**

DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPERS

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2. Candidates have to **attempt all five** questions from each unit amongst the alternatives.

PAPER – II A (F.M. 50)

UNIT : 03 (50 MARKS)

1. Blood :

Bone marrow. Formed elements of blood–origin, formation, functions and fate Plasma proteins– normal values, origin and functions. Haemoglobin – Structure, reactions, biosynthesis and catabolism. Foetal haemoglobin. Abnormal haemoglobins- Sickle-cell anemia and Thalassemia. Different types of anaemia and their causes. Blood volume – normal values, regulation and determination by dye and radioisotope methods. Hemostasis – factors, mechanism, anticoagulants, procoagulants. Disorders of hemostasis-Hemophilia, Thrombosis and Embolism. Blood group – ABO and Rh. Erythroblastosis foetalis. Blood transfusion and its hazards. **(14 Lectures)**

2. Cardiovascular System – I :

Anatomy of the heart. Properties of cardiac muscle. Origin and propagation of cardiac impulse. Stannius ligature. The cardiac cycle- pressure and volume changes. Heart sounds. Murmurs.Cardiac output – measurement by application of Fick's principle and dye dilution method, factors affecting. Starling's law of heart. Electrocardiography – the normal electrocardiogram, electrocardiographic leads, vectorial analysis, the vectorcardiogram, the mean electrical axis of heart. The His bundle electrogram. Principles of Echocardiography. Cardiac Arrhythmias – Normal cardiac rate. Myocardial Infarctions. **(14 Lectures)**

3. Cardiovascular System – II :

Functional morphology of arteries, arterioles, capillaries, venules and veins, sinusoids. General pattern of circulation and significance of branching of blood vessels. The pulse – arterial and venous. Hemodynamics of blood flow. Blood pressure – its measurement and factors affecting. Cardiovascular homeostasis – neural and chemical control of cardiac functions and blood vessels. Cardiac and vasomotor centers, baroreceptors and chemoreceptors, innervation of the heart and blood vessels, cardiac and vasomotor reflexes. Cardiovascular adjustment after haemorrhage.

(10 Lectures)

4. Body Fluids and Regional Circulation :

Lymph and tissue fluids – formation, circulation, functions and fate. Lymphatic organs- Histological structures and functions of lymph gland and spleen. Regional circulations – cerebral, coronary, pulmonary and hepatic, skeletal muscle. **(08 Lectures)**

5. Respiratory System :

Anatomy and histology of the lung and airways. Mechanics of breathing **–** role of respiratory muscles, glottis. Lung volumes and capacity. Compliance of lungs and chest wall, pressure-volume relationships, alveolar surface tension and surfactant, work of breathing. Ventilation- perfusion ratio. Dead space and uneven ventilation. Spirometry. Transport of gases in body - Partial pressure and composition of normal atmospheric gases in inspired, expired, alveolar airs and blood. Oxygen dissociation curve of hemoglobin and myoglobin – factors affecting. Carbon dioxide dissociation curve. Regulation of respiration **–** neural and chemical, respiratory centers, chemoreceptors, baroreceptors, pulmonary receptors. Hypoxia – types, effects. Asphyxia, Voluntary hyperpnoea, Apnoea, Cyanosis, Periodic breathing, Asthma, Emphysema. Lung function tests. Artificial respiration. Concept of non-respiratory functions of lung. **(14 Lectures)**

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Practical

PAPER – IIB (F.M. 50)

Unit – 04 : 50 Marks

1. Histology : 30 Marks

(a) Haematological experiments : Preparation and staining of blood film with Leishman's stain. Identification of blood corpuscles.Differential count of WBC. Total count of RBC and WBC. Haemoglobin estimation. Preparation of haemin crystals. Preparation and staining of bone marrow smear. Measurement of diameter of megakaryocyte. Reticulocyte staining. Blood group determination.

Demonstration: Haematocrit, MCV, MCH and MCHC. Bleeding time, Clotting time, ESR. 15 Marks

(b) Study and identification of stained section of different mammalian tissues and organs : Bone, Hyaline cartilage, Trachea, Lung, Spleen, Lymph gland, Parotid gland, Submaxillary gland, Sublingual gland, Tongue, Oesophagus, Stomach, Duodenum, Jejunum, Ileum, Large intestine, Liver, Kidney, Ureter, Pancreas, Adrenal gland, Thyroid gland, Testis, Ovary, Spinal cord, Cerebral cortex, Cerebellum, Skin, Cardiac muscle, Skeletal muscle, Smooth muscle, Artery, Vein, Uterus**.** 10 Slides-15 Marks

2. Biochemistry Qualitative : 10 Marks

Tests for identification of physiologically important substances : hydrochloric acid, lactic acid, uric acid, albumin, gelatin, peptone, starch, dextrin, glucose, fructose, lactose, sucrose, urea, acetone, glycerol, bile salts.

3. ***Viva – Voce*** : **5 Marks**

4. Laboratory Note -Books : 5 Marks

PART – II

Theoretical

PAPER – III (F.M. 100)

UNIT : 05 (50 Marks)

1. Nervous System I :

A brief outline of organization and basic functions (sensory, motor and association) of the nervous system (central and peripheral). Structural organization of different parts of brain and spinal cord. Reflex action – definition, reflex arc, classification and properties. Autonomic nervous system : organization, outflow, ganglia, centers and functions. Chemical transmission in autonomic nervous systems. Central control of autonomic nervous system. CSF: formation, circulation and functions. Blood-CSF and Blood-Brain barrier. **(10 Lectures)**

2. Nervous System II :

Ascending and descending tracts : origin, courses, termination and functions. Lower and upper motor neurones. Functions of the spinal cord with special reference to functional changes following hemisection and complete section of spinal cord – Brown-Sequard syndrome. Spinal animal. Pain production, perception and regulation. Referred pain. **(14 Lectures)**

3. Nervous System III :

Decerebrate rigidity, decorticate rigidity. Postural reflexes. Muscle spindle and golgi tendon organ: their structure, innervations and functions, regulation of muscle tone. Structure, connections and functions of cerebellum. Structure and functions of vestibular apparatus. Nuclei, connections and functions of thalamus and hypothalamus. Basal nuclei : structure, connections and functions. Cerebral cortex : histological structure, localization of functions. **(14 Lectures)**

4. Nervous System IV :

Limbic system: structure, connections and functions. Physiology of emotion. Electrophysiology of brain: spontaneous electrical activity of brain, EEG and ECoG, evoked potential, DC potential. Isolated cortex. Higher functions of nervous system: conditioning, learning and short-term and long-term memory. Speech. Aphasia. Asymmetrical organization of certain cognitive functions-split brain. Reticular formation: organization, connection and functions of ascending and descending reticular formation. Physiological basis of sleep and wakefulness. **(14 Lectures)**

5. Molecular neurobiology :

General concept of ionotropic and metabotropic receptors. Structure, sub-types, and functions of nicotinic and muscarinic acetylcholine receptors, adrenoceptors, glutamate receptors (NMDA and AMPA receptors), GABA, opiate, serotonin, dopamine and histamine receptors. **(08 Lecturers)**

UNIT : 06 (50 MARKS)

1. Instruments :

Principles of construction and uses of compound microscope, phase contrast microscope, fluorescence microscope, polarizing microscope, confocal microscopy, transmission and scanning electron microscope, photoelectric colorimeter. Brief idea of CRO, CT scan, fMRI and PET. **(12 Lectures)**

2. Renal Physiology :

Anatomy of kidney. Histology of nephron. Renal circulation – peculiarities and autoregulation. Formation of urine – glomerular function and tubular functions. Counter-current multiplier and exchanger. Renal regulation of osmolarity and volume of blood fluids. Diabetes insipidus. Formation of hypertonic urine. Renal regulation of acid-base balance, acidification of urine. Renal function tests – creatinine, inulin, urea, and PAH clearance tests. Physiology of urinary bladder and micturition. Composition of urine. Abnormal constituents of urine, their detection and significance. Renal dialysis. Non-excretory functions of kidney. **(14 Lectures)**

3. Sensory Receptors, Olfaction & Gustation :

Classification of general and special senses. Receptors as biological transducers. Muller's law of specific nerve energies. Weber-Fechner law, Steven's power law. Sensory transduction in Pacinian corpuscle. Adaptation of receptors – phasic and tonic adaptations.
Olfaction and Gustation : Structure and functions of the receptor organs , nerve pathways, centers. Properties of olfactory and gustatory sensation and their transduction & coding.Electro-olfactogram. Abnormalities of olfactory and taste sensation. **(10 Lectures)**

4. Audition :

Audition : Sound waves, decibel. Structure and functional significance of auditory apparatus – external, middle and internal ears. Organ of Corti .Auditory transduction. Auditory pathways and centers. Mechanism of hearing and its modern theories. Different electrical potentials of internal ear. Discrimination of sound frequency and loudness.Localization of sound source. Audiometry. Deafness. **(10 Lectures)**

5. Vision :

Structure of the eyeball. Structure of lens. Cataract .Formation, circulation and functions of aqueous humour, glaucoma. Mechanism of accommodation. Pupillary reflexes light reflex, near response. Argyll-Robertson pupil. Errors of refraction and their corrections. Histological details of retina, peripheral retina, fovea and blind spot. Retinal detachment. Visual pathway and centers. Effects of lesion in visual pathway. Photopic and scotopic vision. Chemical and electrical changes in retina on exposure to light. Visual processing in the retina. Electroretinogram. Positive and negative after- images. Contrast phenonmenon. Light and dark adaptation. Colour vision and its modern concept. Colour blindness.Visual field– perimetry. Visual acuity – measurement, mechanism and factors affecting. Critical fusion frequency. **(14 Lectures)**

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PAPER – IV A (F.M. 50)

UNIT : 07 (50 MARKS)

1. Biological Oxidation and Carbohydrate Metabolism :

Biological oxidation – Redox Potential, Mitochondrial Electron Transport Chain, Oxidative Phosphorylation – Inhibitors and uncouplers.
Carbohydrate - Glycolysis, R-L cycle, TCA cycle, Gluconeogenesis - Cori cycle, Glucose-Alanine cycle.Anaplerotic reactions and Amphibolic nature of TCA cycle. Pentose Phosphate Pathway. Glycogenesis and Glycogenolysis.
*Hormonal regulation of the above mentioned biochemical pathways/cycle not require.***(12 Lectures)**

2. Amino acids and Purine & Pyrimidine Metabolism :

Amino acids - Amino acid pool. Deamination, transamination, amination and decarboxylation. Synthesis of Urea and Nitric oxide. Basic idea of glucogenic and ketogenic amino acids. Metabolism of glycine, sulfur-containing amino acids, tryptophan and phenylalanine.
Purines and Pyrimidines – Biosynthesis : *de novo* and salvage pathways. Catabolism.
Regulation of the above mentioned biochemical pathways/cycle not required. **(10 Lectures)**

3. Lipid Metabolism and Reactive Oxygen Species :

Lipid – β-oxidation and biosynthesis of saturated and monounsaturated fatty acids. Metabolism of Triglycerides. Biosythesis of Lecithin, Cephalin and Cholesterol. Metabolism of Adipose Tissue.Role of lipoproteins in transport and storage of lipids.
Formation of Reactive Oxygen Species and the role of Catalase, Superoxide Dismutase, Glutathione Peroxidase and Glutathione Reductase in combating oxidative stress – role of vitamins.
Hormonal regulation of the above mentioned biochemical pathways/cycle not required.
(12 Lectures)

4. Methodologies :

Chromatography: Principles and uses of : TLC, Gel filtration, Affinity chromatography ion-exchange chromatography. Electrophoresis: Principles and method, uses of Agarose gel electrophoresis, SDS – PAGE. Ultracentrifugation: moving boundary and density gradient ultracentrifugation. Radioactivity – Classification and properties. Their use – radiolabelling of biomolecules and its detection by autoradiography. Principles of radioimmunoassay (RIA), ELISA. Immunoblotting. **(10 Lectures)**

5. Molecular Biology :

DNA replication—Meselson and Stahl Experiment, DNA Polymerases, Ligases and other regulatory proteins. Transcription – RNA Polymerase and other regulatory mechanism in prokaryotes. Genetic code – properties and wobble hypothesis. Translation – codon-anticodon interaction and mechanism in prokaryotes. Regulation of gene expression : operon concept – the lac operon. Gene mutation – agents and types. DNA repairing processes. Concept of oncogenes and properties of cancer cells. Elementary idea of recombinant DNA technology and its applications – gene therapy, transgenic animal. Northern and Southern blotting. **(16 Lectures)**

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Practical
PAPER – IV B (F.M. 50)

UNIT : 08

1. Histology : 10 Marks

Fresh tissue experiments : Suitable staining and examination of fresh tissues – epithelial, areolar, adipose(Sudan III or IV) and muscle tissues. Silver nitrate preparation of cornea and urinary bladder for cell spaces and sciatic nerve for nodes of Ranvier.

2. Biochemistry Quantitative : 15 Marks

Quantitative estimation of glucose and sucrose by Benedict's method. Quantitative estimation of amino nitrogen (Sorensen's formol titration method).P*ercentage and total quantity to be done.* Estimation of percentage quantity of lactose in milk by Benedict's method.

3. Experimental Physiology: 15 Marks

a) Study and use of kymograph, induction coil, key and tuning fork.
b) Gastrocnemius-sciatic preparation and kymographic recording of isotonic muscle twitch.
c) Effect of temperature on muscle twitch.
d) Effect of two successive stimuli on muscle twitch.
e) Effect of load (after-load) on muscle twitch. Calculation of work done by the muscle.
f) Normal tracing of unperfused heart beat of toad.
g) Effects of temperature on unperfused heart beat toad.

Demonstration : 1. Gastrocnemius-sciatic preparation and its use in recording effects of make and break shocks of progressively rising intensity.
2. Effect of load (free-load) on muscle twitch.
3. Determination of nerve conduction velocity by kymographic recording of simple twitches.

3. *Viva-Voce* : 5 Marks

4. Laboratory Note-Books : 5 Marks

PART – III

Theoretical

PAPER – V (F.M. 100)

UNIT : 09 (50 MARKS)

1. General Endocrinology I :

Classification of endocrine glands and hormones. Methods of study of endocrine functions. Hypothalamus as a neuroendocrine organ. Anterior and posterior pituitary – histological structure of the gland. Chemical nature, mode of action, functions and regulation of secretion of their hormones. Hypo- and hyperactive states of the gland. Pineal gland – histological structure. Chemical nature, biosynthesis, mode of actions, functions and regulation of secretion of melatonin. (**14 Lectures**)

2. General Endocrinology II :

Thyroid and parathyroid – histological structure of the glands. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Hypo- and hyperactive states of the glands. Thymus – histological structure of the gland. Chemical nature, mode of action and functions of thymic hormones. **(12 Lectures)**

3. General Endocrinology III :

Adrenal cortex and medulla – histological structure of the gland. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Biosynthesis and catabolism of catecholamines. Hypo- and hyperactive states of the gland. Heart as an endocrine organ. Prostaglandins and Kinins. (**12 Lectures**)

4. General Endocrinology IV :

Pancreatic islets – histological structure. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Hormonal control of blood sugar. Hyperinsulinism and diabetes mellitus. Growth factors –EGF, TGF, PDGF, IGF and FGF. Chemical nature, mode of action, functions. Gastro-intestinal hormones – Chemical nature, mode of action, functions and regulation of secretion of the hormones. (**14 Lectures**)

5. Chronobiology :

Different types of physiological rhythms – ultradian, circadian, infradian. Different zeitgebers and their relation with circadian clock. Hormonal biorhythms and their significance: adrenocortical, pineal and prolactin. Body temperature rhythm. Neural basis of biological clock and role of suprachiasmatic nuclei. Sleep-wakefulness cycle.Time keeping genes. Jet-lag and shift work. (**08 Lectures**)

UNIT : 10 (50 MARKS)

1.Reproductive Physiology I :

Primary and accessory sex organs and secondary sex characters. Histology of testis. Endocrine functions of testis. Spermatogenesis. Hypothalamic control of testicular functions. Histology of ovary. Ovarian hormones and their functions. Oogenesis and ovulation. Formation and functions of corpus luteum. Hypothalamic control of ovarian functions. Physiology of puberty. **(14 Lectures)**

2. Reproductive Physiology II :

Estrous cycle. Menstrual cycle and its regulation. Abnormalities in menstrual cycle. Onset of menopause and post-menopausal changes. Structure and functions of placenta. Maintenance of pregnancy and the bodily changes during pregnancy. Parturition. Pregnancy tests. Development of mammary glands, lactation and their hormonal control. **(14 Lectures**)

3. Developmental Biology :

Basic concepts of stem cells : Totipotency, Differentiation - Committed stem cell. Fertilization, Blastulation, Implantation,Gastrulation, Placentation. Development of alimentary canal, heart, urinary system and genital system. Foetal circulation. Ossification of bone.

(12 Lectures)

4. Nutrition and Dietetics :

Constituents of food and their significance. Basal metabolic rate -factors, determination by Benedict-Roth apparatus. Respiratory quotient. Specific dynamic action. Calorific value of foods. Body calorie requirements – adult consumption unit. Dietary requirements of carbohydrate, protein, lipid and other nutrients. Balanced diet and principles of formulation of balanced diets for growing child, adult man and woman, pregnant woman and lactating woman. Nitrogen balance, essential amino acids, biological value of proteins – measurement and factors affecting. Proteins sparers. Supplementary value of protein. Protein efficiency ratio and net protein utilization of dietary proteins. Dietary fibres. Principle of diet survey. Composition and nutritional value of common food stuffs. Physiology of starvation and obesity. **(12 Lectures)**

5. Social Physiology :

Population problem – principles and methods of family planning,. Problem of infertility and Assisted Reproductive Technologies. Malnutrition – PCM, marasmus, kwashiorkor, marasmic kwashiorkor, endemic goiter, nutritional anemias, rickets, osteomalacia, xeropthalmia, beriberi and their social implications. Principles and social importance of immunization against diseases. Epidemiology and prevention of cholera, malaria, hepatitis and AIDS. **(08 Lectures)**

DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPERS

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PAPER –VI (F.M. 100)

UNIT :11 (50 MARKS)

1. **Work Physiology and Ergonomics :**

Physical work—its definition and nature—isotonic, isometric and isokinetic, positive and negative work. Concept of physiological work. Power and capacity relation. Work-load – light, moderate(submaximal) and heavy (maximal) depending on intensity and duration of work. Exercise inducing equipment – bicycle ergometer, treadmill and stepping stool. Energetics of work – sources of energy and energy demand for different activities. Assessment of energy cost of various physical work – direct and indirect methods with their limitations. Physiological responses to work – cardiovascular, respiratory, metabolic and muscular – short-term and long-term. Work-rest cycle and importance of rest pause. Ergogenics aids. Basic concept of ergonomics and its application in industry to improve efficiency and industrial safety as well as to restrict occupational health hazards. Anthropometry and its implication in ergonomics in general. **(15 Lectures**)

2. **Sports Physiology:**

Concept of endurance, strength and speed in sports activities. Physical training – principles and their impact on performance level in sports with reference to cardiovascular, respiratory and muscular changes. Overtraining and detraining. Warm up and cool down. Brief general idea about nutritional aspects of sports. Aerobic and anaerobic power—concept, factors affecting, methods of measurement and significance of maximal oxygen consumption and excess post exercise oxygen consumption. Lactate threshold, lactate tolerance and their usefulness. Concept of recovery processes and occurrence of fatigue in physical work. Concept of physical fitness and its assessment by Harvard and modified Harvard Step Tests. **(15 Lectures)**

3. **Skin and Body Temperature Regulation** :

Structure and functions of skin. Cutaneous circulation. Sweat glands –structure and composition of sweat. Sweat formation, secretion and its regulation. Insensible perspiration. Regulation of body temperature in homeotherms – its physical and physiological processes, roles of neural and hormonal processes. Pyrexia, hyperthermia and hypothermia.

(10 Lectures)

4. **Human and Environment I :**

Environment – Physical and biological aspects. Effects of exposure to hot and cold environment. Acclimatization to hot and cold environment. Heat disorders and its preventive measures. Effects of hypobaric and hyperbaric environment. Caisson disease. Preventive measure for hypobaric and hyperbaric effects. Acclimatization to high altitudes. **(10 Lectures)**

5. **Human and Environment II :**

G force, ionizing and non-ionizing radiations - physiological effects and preventive measures. Air, noise and water pollutions – causes, effects, prevention measures and control. Brief idea of the hazards of pesticides, carcinogens, mutagens, neurotoxins and war gases. Impact of green house effects on life. **(10 Lectures)**

UNIT : 12 (50 MARKS)

1. Microbiology I:

Classification of microorganisms. Techniques employed for the identification of microorganisms -- microscopic and biochemical methods. Control of microbial growth : Physical and Chemical methods used in sterilization, disinfection and pasteurization. Bacteriology : Bacterial classification based on staining techniques (Gram stain and Acid-fast stain) and morphological aspect. Bacterial structure : cell-wall, LPS layer, pili, flagella, chromosome, plasmid spores and cysts. Culture of bacteria : nutritional requirement – complex and synthetic media, preparation of media ; physical factors required for growth (temperature, pH and gaseous requirement) ; bacterial growth curve : different phases and their significance ; quantitative estimation of bacterial growth ; continuous growth culture and its utility.

Food microbiology : beneficial and harmful microorganisms in food, causative organisms of food-borne infections- mode of transmission and methods of prevention. **(12 Lectures)**

2. Microbiology II :

Bacterial metabolism: fermentation, glyoxalate cycle and Entner-Doudoroff pathway. Bacterial genetics : transformation, conjugation and transduction. Treatment of bacterial infection : chemotherapeutic agents, antibiotics- definition, bactericidal and bacteriostatic and their mechanism of action.

Virology : Viral structure – virion, prion and bacteriophages ; classification of viruses based on nucleic acid composition and host system, replication of bacteriophages – lytic and lysogenic cycles. **(10 Lectures)**

3. Immunology :

Overview of innate and acquired immunity. Elements of acquired immunity : characteristics of immune response, cells and organs involved in immune response. Immunogens and antigens : requirements of immunogenicity, epitopes recognized by B- & T- cells, haptens, adjuvants, cross-reactivity. Antibody structure, classification and functions. Kinetics of antibody responses : primary & secondary. Antigen - antibody interactions - Primary interaction : association constant, affinity & avidity. Secondary interaction : precipitation & agglutination. B-cell receptor. MHC molecules : structure of class I and II molecules, brief idea of peptide binding by MHC molecules, cellular distribution. Antigen processing and presentation. T-cell receptor. T-cell maturation and differentiation - thymic selection in brief. B-cell activation & differentiation : thymus dependent and independent antibodies, T-B co-operation, the carrier effect. Cytokines : produced by T_{H1} & T_{H2} cells, regulating specific immune response only. Complement : Activation components – classical, alternative and lectin. Biological consequence of complement activation. Cell-mediated effector responses : CTLS, NK cells, K cells. Immune responses in allergy. Brief idea of autoimmunity and AIDS. Vaccination : Passive and active immunization, types and uses of vaccine. Toxins and toxoids. Hybridoma technology. **(14 Lectures)**

4. Pharmacology :

The importance of pharmacology in the study of physiological processes. Definition of drug, agonist and antagonist. Drug delivery Drug reactivity. Pharmacokinetics : Drug-receptor interaction, Desensitization of receptors, Absorption, Distribution, Permeation, Elimination, Clearance,Half-life.Pharmacodynamics:dose-response curves.Beneficial versus toxic effects of drugs. Drug biotransformation. Bioavailability. Drug accumulation. Drug toxicity – LD50, ED50, therapeutic index.

Anaesthetics : types and mechanism of action of general anaesthetics.

Sedatives - hypnotics: benzodiazepine, zolpidem.

Diuretics - Carbonic anhydrase inhibitor, loop diuretic, potassium sparing and osmotic diuretics.

Neuromuscular blockers : Tubocurarine and succinyl choline.

Organ system effects and mechanism of action of adrenoceptor agonists and antagonists:

Adrenergic stimulants : Amphetamine and ephedrine. α- adrenergic stimulants – Methaxomine and clonidine. β- adrenergic stimulants – Metaproterenol and salbutamol.

Adrenergic antagonists : Labetelol. α- adrenergic blockers – Phenoxybenzamine and phentolamine. β- adrenergic blockers – Propranolol and atenolol.

Antianginal drugs : Nitroglycerine and calcium-channel blocker – Nifedipine and verapamil. **(12 Lectures**)

5. Biostatistics :

Scope of statistics – utility and misuse.Principles of statistical analysis of biological data. Basic concepts – variable, parameter, statistics. Sampling. Presentation of data-frequency distribution, frequency polygon, histogram, bar diagram and pie diagram. Parameters. Different classes of statistics- mean, median, mode, mean deviation, variance, standard deviation, standard error of the mean. Standard score. Degrees of freedom. Probability. Normal distribution. Student's t-distribution. Testing of hypothesis - Null hypothesis, errors of inference, levels of significance, t-test and z score for significance of difference. Distribution-free test - Chi-square test. Linear correlation and linear regression.

(12 Lectures)

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Practical

PAPER – VII (F.M. 100)

UNIT : 13

1. Biochemical Estimation : 40 Marks

i) Blood Sugar by Folin-Wu Method ; ii) Serum Protein by Biuret Method ; iii) Serum Albumin using Bromocresyl Green ; iv) Estimation of RNA by orcinol method ; v) Blood Uric Acid by cyanide-free method ; vi) Serum urea by DAM method.

2. Experimental Physiology : 25 Marks

Preparation of amphibian Ringer solution. Kymographic recording of perfused heart beat of toad. Study of the effects of changes in perfusion fluid pressure, excess calcium and potassium ion concentration, acetylcholine, adrenaline.

3. Microbiology & Biochemical Technique : 10 Marks

(a) Gram staining of bacteria and identification of Gram positive and Gram negative bacteria.
Demonstration: Spore Staining, Immuno-diffusion.
(b) Isolation of amino acids from an artificial mixture using paper chromatography.

4. *Viva - Voce* : 15 Marks

5. Laboratory Note - Books : 10 Marks

PAPER –VIII (F.M. 100)

UNIT : 14

1. Histology : 15 Marks

Staining of sections by haematoxylin-eosin and iron-haematoxylin.
Demonstration : Preparation of permanent slides – fixation, dehydration, paraffin embedding, block preparation, cutting and staining.

2. Experimental Physiology: 20 Marks

Kymographic recording of normal movements of rat's intestine in Dale's apparatus. Effects of hypoxia, acetylcholine and adrenaline on normal intestinal movements.

3. Experiments on Work Physiology and Ergonomics using human subjects : 15 Marks

a) Sphygmomanometric measurement of arterial blood pressure at rest and after exercise.
b) Modified Harvard step test and determination of physical fitness. Recording of recovery heart-rate after standard exercise and graphical plotting.
c) Pneumographic recording of effects of talking, drinking, laughing, coughing, exercise, hyperventilation and breath - holding.
d) Spirometric measurement of vital capacity.
e) Measurement of some common anthropometric parameters- stature, weight, eye height, shoulder height, eye height (sitting), elbow height, sitting height, elbow rest height (sitting), knee height (sitting), shoulder elbow length, arm reach from wall, elbow-to-elbow breadth, knee-to-knee breadth (sitting), shoulder breadth, head length, head breadth, head circumference and neck circumference, mid-arm circumference, waist circumference, hip circumference, chest circumference.
f) Calculation of Body Surface Area (using nomogram), Body Mass Index and Ponderal Index from anthropometric measurements.

2. Biostatistics : 10 Marks

Computation of mean, median, mode, standard deviation and standard error of the mean with physiological data like body temperature, pulse rate, respiratory rate, height and weight of human subjects. Graphical representation of data in frequency polygon and histogram. Student's t test for significance of difference between means.

Demonstration: Statistical analysis and graphical representation of biological data with computer application program (Microsoft Excel).

3. Social Physiology : Diet survey and Field Study record : 15 Marks

a) Diet survey report (hand-written) of a family (as per ICMR specification) : Each student has to submit a report on his/her own family. 8 Marks
b) A report (hand-written) on the basis of field survey from ONE of the followings: 7 Marks
    1. Physiological parameters of human (at least three parameters).
    2. Anthropometric measurements on human (at least three parameters).
    3. Epidemiological studies on human.
    4. Project work on animals involving physiological parameters (at least three parameters).
c) Optional : Visit to Institute of national importance engaged in physiological, biomedical, biochemical and nutritional research.

4. *Viva Voce* : 15 Marks

5. Laboratory Note - Books : 10 Marks

RECOMMENDED BOOKS FOR PHYSIOLOGY (HONOURS) Parts I, II & III Courses

(The latest edition available should be used for all books)

1. Text book of Medical Physiology, by A.C. Guyton. W.B. Saunders Co.
2. Best & Taylor's Physiological Basis of Medical Practices, edited by B.K. Brobeck. The William and Wilkins Co.
3. Review of Medical Physiology. By W.F. Ganong, Lange Medical Book. Prentice-Hall International.
4. Harper's Biochemistry, by R.K. Murry and others. Lange Medical Book. Prentice-Hall International.
5. Lehninger's Principles of Biochemistry. By D.L. Nelson and M. M. Cox, Worth Publishers Inc.
6. Text Book of Biochemistry, by E.S. West. W.R. Todd. H.S. Mason. J.T. Van Bruggen. The Macmillan Company.
7. Biochemistry. By D.Das, Academic Publishers.
8. Biophysics and Biophysical Chemistry, by D.Das. Academic Publishers.
9. Samson Wright's Applied Physiology. Edited by C.A. Keele. E Neil & N. Toels. Oxford University Press.
10. Physiology, by R.M. Berne & M.N. Levy, C.V. Mosby Co.
11. Basic Histology, by L.C. Junqueira & J Carneiro, McGraw- Hill .
12. Histology- A Text and Atlas, by M.H. Ross & E.J. Reith. The Williams and Wilkins Company.
13. Bailey's Text Book of Histology, revised by W.M. Copenhaver; The Williams and Wilkins Company.
14. The Cell – A Molecular Approach, G.M. Cooper & R.E.Hausman, ASM Press SINAUER.
15. Core Text Book of Neuro-Anatomy, by M.B. Carpenter; the Williams and Wilkins Company.
16. The Human Nervous System, by Charles Nobach, Mc Graw Hill Book Co.
17. Biomedical Instrumentation & Measurements, by L. Cromwell, F.J. Weibell & E.A. Pfeiffer; Prentice-Hall of India Pvt Ltd.
18. The Human Nervous System. By M.L. Barr & J.A. Kierman, Harper & Row.
19. Essential Food and Nutrition, by M. Swaminathan. The Bangalore Printing & Publishing Co. Ltd.
20. Essential Immunology, by I.M. Roitt, Blackwell Scientific Publications.
21. Kuby Immunology, by R.A. Goldsby. T.J. Kindt and B.A. Osborne, W.H. Freeman and Co.
22. Microbiology, by M.J. Pelczer & Others; Tata McGraw Hill Publishing Co Ltd.
23. Cellular & Molecular Biology,by EDP De Robertis & EMF De Robertis; Lea & Febiger.
24. Molecular Biology of the Gene, by J.D. Watson, H.H. Nancy & others; Benjamin-Cummings.
25. Molecular Biology of the Cell, by B. Alberts and others, Garland.
26. Textbook of Medical Physiology, Indu Khurana, Elsevier.
27. Carleton's Histological Techniques, by R.A.B. Drury & E.A. Wellignton, Oxford University Press.
28. Handbook of Experimental Physiology and Biochemistry, by P.V. Chadha; Jaypee Brothers Medical publishers.
29. Neurobiology, by G.M. Shepherd, Oxford University Press
30. Biochemistry, by L. Stryer, W.H. Freeman and Co.
31. Molecular Cell Biology, by H. Lodish, D. Baltimore & others. Scientific American Book.

32. Genetics: Analysis of Genes and Genomes, by DL Hartl and EW Jones & Burtlet Publishers.
33. William's Text Book of Endocrinology Larsen *et al*.,: An Imprint of Elsevier.
34. Endocrinology, Mac E. Hadley, Pearson Education.
35. The Kidney-An outline of Normal and Abnormal Functions, by H.E. Dewardener, ELBS.
36. Physiology of Respiration by J.H. Comroe. Year Book Medical Publihsers.
37. Text Book of Physiology. Vols. I & II by H.D. Patton. A.F. Ruchs. B.Hille. A.M. Scher and R. Sleiner. W.B. Saunders of Co.
38. The Physiological Basis of Physical Education and Athletics by E.L. Fox and D.K. Mathews. Saunders College Publishing.
39. Statistics in Biology and Psychology by D.Das Academic Publishers.
40. An Introduction to Biostatistics, N. Gurumani, M.J.P. Publishers, Chennai.
41. Pesticides by P.K. Gupta, Interprint.
42. Environmental Chemistry by P.V. De. Wiley Eastern Ltd.
43. Exercise Physiology – Energy, Nutrition and Human Performance by W.D. McArdle, F.Katch and V.L. Katch. Lippincott,Williams and Wilkins.
44. Essentials of Exercise Physiology by L.G. Shaver, Surjeet Publications.
45. Text Book of Environmental Physiology by C. Edger Folk Jr. Lea and Febiger.
46. Goodman & Gilman's The Pharmacological Basis of Therapeutics, McGraw-Hill.
47. Quintessence of Medical Pharmacology, S.K. Chaudhuri, New Central Book Agency.
48. Essentials of Medical Pharmacology, KD Tripathi, Jaypee.
49. Text book of Work Physiology by P.O. Astrand and K. Rodahl. Mc Graw- Hill Book Co.
50. Human Factors in Engineering and Design by E.O. McCormick and M. Sanders. Tata McGraw Hill.
51. Energy,Work and Leisure J.V.G.A.Durin and R.Passmore,Heinemann Educational Books.
52. Sports Physiology by E.L. Fox, Saunders College Publishing. Holt-Saunders.
53. Vander's Human Physiology, E.P. Widmaier *et al*., McGraw-Hill, Higher Education.
54. Concise Medical Physiology by S.K. Chaudhuri, New Central Book Agency.
55. Medical Physiology by A.B. Mahapatra, Current Books International.
56. Endocrinology. Vols.I , II and III by L.O. DeGroot. W.B. Saunders Co.
57. The Physiology of Reproduction, Vols.I & II, by E. Knobil and J.D. Neil. Raven Press.
58. Park's Text Book of Preventive and Social Medicine by K. Park, M/s. Banarsidas Bhanot Publishers.
59. Langman's Medical Embryology by J.W. Sadler, Lippincott,Williams and Wilkins.
60. Essentials of Human Embryology by A.K. Datta. Current Books International.
61. Human Embryology by I. Singh & G.P.Pal, McMillan.
62. The Circadian System of Man by R.A. Wever, Spinger-Verlag.
63. The Clocks That Time Us, by M.C. Moore- Ede and others, Harvard University Press.
64. Circadian Rhythms and the Human, by D.S. Minors and J.M. Waterhouse. Wright. PSG.
65. The Physiological Clock: Circadian Rhythms and Biological Chronometry, E. Bunning, Springer-Verlag.
66. Textbook of Pharmacology, SD Seth, B.I. Churchill Livingstone.
67. Basic and Clinical Pharmacology by E.G. Katzung. Appleton and Lange.
68. An Introduction to Biological Rhythms, by D. Palmer, Academic Press
69. Medical Statistics by B.K. Mahajan. Jaypee Brothers, Medical Publishers Pvt. Ltd.
70. Statistical Methods by G.W. Snecedor and W.G. Cochran, Oxford & IBH Publishing Co. Pvt. Ltd.
71. Theory and Practice of Histological Techniques by J.D. Bancroft & A. Stevens, Churchill Livingstone.

72. Practical Biochemistry in Medicine by Srinivas Rao., Academic Publishers.
73. Practical Physiology, by M.K. Manna, Sritara Prakashani, Kolkata

Note Books of Practical Biochemistry, Experimental Physiology and Histology
(Published by the Physiological Society of India, Kolkata)

Note : In order to maintain the uniformity of practical knowledge among the students of different Colleges, Physiological Society of India has published Practical Note Books in Physiology comprising syllabi of different Universities including Calcutta University with the help of experienced teachers including dignitaries of both Honours and General teaching degree colleges. Hence, members of the Undergraduate Board of Studies in Physiology recommend the aforesaid Note Books (Experimental, Biochemistry and Histology) for use by the students in undergraduate degree course (Honours practical) in Physiology.

GENERAL

PART - I

THEORETICAL

Paper I (F.M. 100)

Unit - 01: 50 Marks	Lectures required (Each period of 45 minutes duration)
1. Units of human system	06
2. Biophysical and Biochemical Principles	10
3. Digestive System	12
4. Biochemistry and Metabolism	14
5. Nutrition and Dietetics	08

Unit – 02 : 50 Marks

1. Blood and Body Fluids	10
2. Heart	10
3. Circulation	10
4. Respiratory system	10
5. Renal Physiology	10

PART - II

THEORETICAL

Paper – II (F.M. 100)	Lectures required (Each period of 45 minutes duration)
Unit - 03: 50 Marks	
1. Muscle Physiology	08
2. Nerve Physiology	10
3. Nervous system I	10
4. Nervous system II	10
5. Sensory Physiology	12

Unit – 04 : 50 Marks

1. Skin and Regulation of Body Temperature	08
2. Endocrine system I	12
3. Endocrine system II	12
4. Reproductive Physiology I	09
5. Reproductive Physiology II	09

PRACTICAL

Paper – III (F.M.100)

(One practical class is of 3 periods) Classes required 70
(Each period of 45 minutes duration)

Unit 05

1. Histology : 30 Marks
   a) Haematological Experiments
   b) Fresh tissue experiments (except haematological experiments) 20 Marks
   c) Identification of histological permanent slides 10 marks
2. Biochemistry : 30 Marks
   a) Qualitative Experiments 10 marks
   b) Quantitative Experiments 20 marks
3. Experimental Physiology (Including Human Experiments) 15 Marks
   a) Amphibian skeletal muscle and heart experiments
   b) Experiments on Human
4. *Viva voce* 15 Marks
5. Laboratory note books 10 Marks

PART - III

THEORETICAL

Paper – IV A (F.M. 70) Lectures required
(Each period of 45 minutes duration)

Unit – 06: 70 Marks

1.	Haematology	10
2.	Biochemistry & Molecular Biology	14
3.	Microbiology and Immunology	10
4.	Social Physiology	08
5.	Work Physiology	10
6.	Environmental Physiology	10
7.	Biostatistics	08

PRACTICAL

Paper - IVB F.M. 30
(One practical class is of 3 periods) Classes required 20
(Each period of 45 minutes duration)

Unit – 07: 30 Marks

1. a) Haematology
   b) Biochemistry } 18 Marks
   c) Human Experiments
2. Field Study Report 4 Marks
3. *Viva voce* 5 Marks
4. Laboratory Note-Books 3 Marks

PART - I

THEORETICAL

Paper I (F.M. 100)

Unit - 01: 50 Marks

1. Units of Human System :

   Structure and functions of plasma membrane, nucleus and different cell organelles – Endoplasmic reticulum, Golgi bodies, Mitochondria, Lysosome and Peroxisome. Structure, function and classification of Epithelial, Connective, Muscular and Nervous tissues. (06 lectures)

2. Biophysical and Biochemical Principles:

   Physiological importance of the following physical processes: Diffusion , Osmosis, Dialysis, Ultrafiltration , Surface tension, Adsorption and Absorption. A brief idea about acids, bases, buffers, indicators. pH – definition, significance and maintenance of pH in the blood. Colloids - definition, classification and physiological importance. Enzymes: definition, classification, factors affecting enzyme action. Concept of coenzymes and isozymes. (10 lectures)

3. Digestive System :

   Structure in relation to functions of alimentary cana1 and digestive glands. Composition, functions and regulation of secretion of digestive juices including bile. Digestion and absorption of carbohydrate, protein and lipid. Movements of the stomach and small intestine. (12 lectures)

4. Biochemistry and Metabolism :

   Carbohydrates : Definition and classification.

   Monosaccharides – Classification, structure. Chemical reactions of monosaccharides (Glucose & Fructose) —– Reactions with concentrated mineral acids, alkali, phenylhydrazine and their biochemical importance.

   Disaccharides – Maltose, Lactose and Sucrose: Structure, occurrence and physiological importance.

   Polysaccharides – Starch, Glycogen, Dextrin, Cellulose.

   Lipids : Definition and classification. Fatty acids —– Classification. Properties of Fat and Fatty acids—Hydrolysis, Saponification,Saponification number, Iodine number, Hydrogenation, Rancidity-Acid number. Phospholipids, Cholesterol & its ester – physiological importance.

   Amino acids, Peptides and Proteins : Classification and structure. Structure of peptide bonds.
   Glycolysis, TCA cycle, Glycogenesis, Glycogenolysis. Gluconeogenesis. Depot fat. Beta oxidation of saturated fatty acid Ketone bodies – formation and significance. Deamination, Transamination. Amino acid pool - fate and functions of amino acids in the body. Formation of urea and its importance. (10 lectures)

5. Nutrition :

   Basic constituents of food and their nutritional significance. Vitamins: definition, classification, functions, deficiency symptom.s and daily requirements. Hypervitaminosis. Mineral metabolism - Ca. P, Fe. BMR: definition, factors affecting, determination by Benedict-Roth apparatus. Respiratory quotient: definition, factors affecting and significance. Biological value of proteins. Essential and non-essential amino acids, Nitrogen equilibrium. Minimum protein requirement-Positive and negative nitrogen balance. SDA : definition and: importance. (08 lectures)

Unit – 02 : 50 Marks

1. Blood and Body Fluids :

Blood: composition and functions. Plasma proteins: origin and functions. Plasmapheresis. Bone marrow. Formed elements of blood - their morphology and functions. Erythropoiesis and leucopoiesis. Haemoglobin : different types of compounds and derivatives. Blood volume and its determination (dye method and radioisotope method) and regulation. Coagulation of blood : mechanism, factors affecting, procoagulants, anticoagulants, and disorders of coagulation. Lymph and tissue fluids: composition, formation, and functions. (10 lectures)

2 Cardiovascular Physiology I :

Anatomy and histology of the heart. Properties of cardiac muscle. Origin and propagation of cardiac impulse. Cardiac cycle : events. Heart sounds. Heart rate. Cardiac output: methods of determination (dye dilution and Fick principle), factors affecting, regulation. (10 lectures)

3. Cardiovascular Physiology II :

Structure of arteries, arterioles, capillaries. venules and veins. Pulse - arterial and venous. Blood pressure and its regulation and factors controlling. Baro- and chemoreceptors. Vasomotor reflexes. Methods of measurement of blood pressure. Peculiarities of regional circulations: coronary, pulmonary, renal, hepatic and cerebral. (10 lectures)

4. Respiratory Physiology :

Anatomy and histology of the respiratory passage and organs. Role of respiratory muscles in breathing. Artificial respiration. Significance of physiological and anatomical dead space. Lung volumes and capacities. Exchange of respiratory gases between lung and blood and between blood and tissues. Transport of oxygen and carbon dioxide in blood. Regulation of respiration - neural and chemical. Hypoxia. (10 lectures)

5. Renal Physiology :

Relationship between structure and functions of kidney. Mechanism of formation of urine. Normal and abnormal constituents of urine. Physiology of urine storage and micturition. Renal regulation of acid-base balance. Non-excretory functions of kidney. (10 lectures)

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PART - II

THEORETICAL

Paper II (F.M. 100)

Unit – 03 : 50 Marks

1. Muscle Physiology :

Different types of muscle and their structure. Red and white muscle. Muscular contraction: structural, mechanical and chemical changes in skeletal muscle during contraction and relaxation. Isotonic and isometric contractions. Properties of muscle: all or none law, beneficial effect, summation. refractory period, tetanus, fatigue. A brief idea about the muscle spindle.

(08 lectures)

2. Nerve Physiology :

Structure and classification of nerves. Origin and propagation of nerve impulse. Velocity of impulse in different types of nerve fiber. Properties of nerve fibers: all or none law, rheobase and chronaxie, refractory period. indefatiguability. Synapses: structure, different types, mechanism of synaptic transmission. Motor unit. Myoneural junction: structure, mechanism of impulse transmission. Degeneration and regeneration in nerve fibers. (10 lectures)

3. Nervous System I :

A brief outline of organization and basic functions (sensory, motor and association) of the nervous system, central and peripheral nervous system. (emphasis on the structure of spinal cord and brain stem). Ascending tracts carrying touch, kinaesthetic, temperature and pain sensations. Descending tracts: pyramidal tract and brief outline of the extra-pyramidal tracts. Pain. Reflex action - definition, reflex arc, classification, properties. Functions of the spinal cord. Outline of functions of brain stem.

(10 lectures)

4. Nervous System II :

A brief idea of the structure, connections and functions of cerebellum. Different nuclei and functions of thalamus and hypothalamus. Cerebral cortex: histological structure and localization of functions. CSF : composition, formation, circulation and functions. A brief description of the organization of the autonomic (sympathetic and parasympathetic) nervous system. Functions of sympathetic and parasympathetic nervous system. A brief idea of speech, aphasia, conditioning, learning and memory.

(10 lectures)

5. Sensory Physiology :

Classification of general and special senses and their receptors. Receptors as biological transducer.

(a) *Olfaction and Gustation:* Structure of sensory organ, neural pathway of olfactory and gustatory sensation. Physiology of olfactory and gustatory sensation. Olfactory and gustatory adaptation. After-taste.

(b) *Audition:* Structure of ear, auditory pathway, mechanism of hearing.

(c) *Vision:* Structure of the eye. Histology of retina. Visual pathway. Light reflex. Chemical changes in retina on exposure to light. Accommodation - mechanism and pathway. Errors of refraction. Positive and negative after-image. Light and dark adaptation. Elementary idea of colour vision and colour blindness. (12 lectures)

Unit – 04 : 50 Marks

1. Skin and Regulation of Body Temperature:

Structure and functions of skin. Insensible and sensible perspiration Regulation of body temperature — physical and physiological processes involved in it. Physiology of sweat secretion and its regulation. (08 lectures)

2. Endocrine System I :

Anatomy of endocrine system. Hormones - classification. Basic concept of regulation of hormone actions. Positive and negative feedback mechanism. Elementary idea of hormone action.

Hypothalamus : Basic concept of neurohormone. Hypothalamo-hypophyseal tract and portal system.

Pituitary: Histological structure, hormones, functions. Hypo and hyperactive states of pituitary gland.

Thyroid: Histological structure. Functions of thyroid hormones (T_4T_3) Thyrocalcitonin. Hypo and hyper-active states of thyroid.

Parathyroid: Histological structure, functions of parathyroid hormone. Tetany. (12 lectures)

3. Endocrine System II :

Adrenal Cortex: Histological structure and functions of different hormones. Hypo and hyper-active states of adrenal cortex.

Adrenal Medulla: Histological structure and functions of medullary hormones. The relation of adrenal medulla with the sympathetic nervous system.

Pancreas: Histology of islets of Langerhans. Origin and functions of pancreatic hormones. Diabetes mellitus.

Brief idea of the origin and functions of renin-angiotensin, prostaglandins. erythropoietin and melatonin. Elementary idea of gastrointestinal hormone. (12 lectures)

4. Reproductive Physiology I :

Primary and accessory sex organs and secondary sex characters. Testis: histology, spermatogenesis, testicular hormones and their functions. Ovary: histology, oogenesis, ovarian hormones and their functions. (09 lectures)

5. Reproductive Physiology II :

Oestrus and menstrual cycles and their hormonal control. Fertilization, implantation and structure and functions of placenta. Maintenance of pregnancy – role of hormones. Development of mammary gland and lactation - role of hormones.

(09 lectures)

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Practical

Paper III (F.M. 100)

Unit – 05

1. Histology : **30 Marks**

Only ONE question will be set from the following two groups [i) & ii)] in the examination (20 Marks) :

i) Haematological experiments :

a) Leishman's staining of human blood film and identification of different types of blood corpuscles.

b) Preparation of Haemin crystals.

ii) Fresh tissue experiments:

a) Examination and staining of fresh tissues (other than blood) squamous, cornified, ciliated and columnar epithelium, skeletal muscle, cardiac muscle by methylene blue stain.

b) Silver nitrate preparation of node of Ranvier.

Demonstration: Staining of adipose tissue by Sudan III or IV.

iii) Identification of permanent slides: Bone, Lung, Trachea, Spleen, Lymph gland, Liver, Salivary gland, Pancreas, Adrenal gland, , Thyroid gland, Spinal cord, Cerebellum, Cerebral cortex, Kidney, Skin, Testis, Ovary, Tongue, Oesophagus, Stomach, Small intestine, Large intestine. (5 slides - 10 Marks)

2. Biochemistry : **30 Marks**

Qualitative Experiments: 10 Marks

Qualitative tests for identification of starch, dextrin, lactose, sucrose, glucose, fructose, albumin, gelatin, peptone, lactic acid, hydrochloric acid, uric acid, acetone, glycerol, bile salts, urea.

Quantitative Experiments: 20 Marks

a) Quantitative estimation of glucose by Benedict's method.

b) Quantitative estimation of amino-nitrogen by Sorensen's formol titration method.
Percentage and total quantity to be done.

Demonstration:

a) Quantitative estimation of Sucrose by Benedict's method.

b) Analysis of wheat, rice, milk and oil to test the presence of carbohydrate, protein and fat.

c) Salivary amylase activity on starch at body temperature (37.5 C), above 40°C and in presence of HCl.

3. Experimental Physiology with Human Experiment : **15 Marks**

a) Use of kymograph, induction coil and key.

b) Recording of simple muscle curve with sciatic-gastrocnemius muscle preparation of toad and determination of latent period, period of contraction and period of relaxation and maximum height of contraction.

c) Normal tracing of toad's unperfused heart beat.

d) Effect of warm saline on toad's unperfused heart beat.

e) Measurement of systolic and diastolic arterial pressure by sphygmomanometer and determination of pulse pressure and mean pressure during rest and exercise.

Demonstration :

a) Effect of temperature on simple muscle twitch.

b) Effect of calcium and potassium ions on unperfused toad's heart beat.

c) Effect of adrenaline/acetylcholine on unperfused toad's heart beat.

4. Laboratory Note Books : **10 Marks**

i) Biochemistry - 4 marks; ii) Histology - 3 marks; iii) Experimental - 3 marks

5. *Viva – voce* **15 Marks**

a) Questions are to be asked from the experiments given in the examination.

i) From Biochemistry - 4 marks; ii) From Histology - 4 marks;

iii) From Experimental -3 marks ; iv) From Instruments – 4 marks

(Questions are to be asked on the different instruments used in the practical classes.)

PART - III

THEORETICAL

Paper IV A (F.M. 70) Unit – 06 : 70 Marks

1. Haematology :

Blood groups - ABO and Rh. Blood transfusion - precaution and hazards. Immunological basis of identification of ABO and Rh blood groups. Functions and estimation of haemoglobin. Abnormal haemoglobins - thalassaemia and sickle-cell anaemia. Definition, determination and significance of TC, DC, ESR, Arneth count, PCV, MCV, MHC, MCHC, bleeding time, clotting time and prothrombin time. Anaemia - types (definition and causes). Leucocytosis, leucopenia and leukaemia. Purpura. (10lectures)

2. Biochemistry and Molecular Biology :

Brief idea of HMP shunt and its significance (detailed enzymatic reactions are not required). Lipoproteins - types and functions. Purine and pyrimidine bases, nucleosides, nucleotides and polynucleotides. Structure of DNA and RNA. Elementary idea of gene, genome, transcription, genetic code, translation and genetic engineering. (10 lectures)

Pathophysiological significance of the following blood constituents: glucose, urea, creatinine, uric acid, cholesterol, bilirubin, SGPT and SGOT, alkaline and acid phosphatases and ketone bodies. (4 lectures)

3. Microbiology and Immunology :

Virus - DNA virus and RNA virus. Bacteriophage. Bacteria-structure and morphological classification. Gram positive and Gram negative and acid-fast bacteria. Pathogenic and non-pathogenic bacteria - definition with a few examples. Sterilization and Pasteurization. A brief idea of antibiotics. Elementary knowledge of innate and acquired immunity. Humoral and cell mediated immunity Vaccination - principles and importance of immunization. Basic principle of immunological detection of pregnancy. (10 lectures)

4. Social Physiology :

Composition and nutritional value of common Indian foodstuffs – rice, wheat, pulses, egg, meat, fish and milk. Dietary fibers. Calorie requirement. Concept of ACU. Principle of balanced diet formulation of individuals - infants, growing children, students, pregnant women, lactating women and aged persons. Dietary management or obese, diabetic person, hypertensive person and athlete. Diet survey. Malnutrition and its causes - PCM, marasmus, kwashiorkor their prevention. Iron and iodine deficiency.

Population problem and its control. Problem of infertility and brief idea about *in vitro* fertilization and intrauterine gamete transfer. Brief idea of AIDS and hepatitis B and their preventions. (08 lectures)

5. Work Physiology :

Physical work - definition and units of measurement. Concept and classification of physical work – static and dynamic work, positive & negative work. Cardiovascular and respiratory changes during physical exercise. Brief idea of maximal aerobic power and excess post-exercise oxygen consumption. Basic idea of doping. EMG. Physical fitness index - Harvard step test. ECG – normal waves and leads. Anthropometry and its uses. (10 lectures)

6. Environmental Physiology :

Environment - its physiological aspects. Effect of extreme temperature on humans. Hypobaric environment - effects on physiological system, acclimatization. Hyperbaric conditions and Caisson disease. Brief idea of cyanosis, dyspnoea, hyperpnoea, apnoea and asphyxia. Some common pollutants and their effects - carbon monoxide, lead and arsenic. Effects of noise on human body and preventive measures. (l0 lectures)

7. Biostatistics :

Basic concepts – variable, population, parameter, sample, statistic. Classification of data – qualitative and quantitative, continuous and discontinuous. Presentation of data–frequency distribution, bar diagram, pie diagram, frequency polygon and histogram. Mean, median, mode, standard deviation and standard error. (08 Lectures)

DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPER

1. From each unit, **seven** questions of 10 marks each with one alternative will be set from the same sub-unit. Each 10 marks question may be sub-divided.
2. Candidates have to **attempt all seven** questions from the unit amongst the alternatives.

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PRACTICAL

Paper IV B (F.M. 30)

Unit – 07 : 30 Marks

1. Any two questions from the following three groups (A, B and C) are to be set in the examination: 9 x 2 = **18 marks**

A. *Haematology:*

a) DC of WBC, estimation of haemoglobin, blood group determination, bleeding time and coagulation time.

Demonstration: Haematocrit, MCV, TC of RBC and WBC, ESR.

B. *Biochemistry:*

a) Identification of normal constituents of urine - chlorIde. sulphate, phosphate, creatinine and urea. Identification of abnormal constituents of urine - glucose, protein, acetone blood and bile salts.

Demonstration: Blood sugar estimation (Folin -Wu method)

C. *Human Experiments:*

a) Determination of Physical Fitness Index (PFI) of an individual by modified Harvard step test and recording of recovery heart-rate after standard exercise.

b) Pneumographic recording of respiratory movements along with the effect of drinking of water, talking, forced hyperventilation and breath holding.

c) Measurement of some common anthropometric parameters : stature, weight, eye height, shoulder height, elbow height. sitting height, elbow rest height (sitting), knee height (sitting), arm reach from wall, mid-arm circumference, waist circumference, hip circumference, neck circumference,head circumference, chest circumference.

d) Calculation of Body Surface Area (using a nomogram) and Body Mass Index from anthropometric measurements.

Demonstration:

a) Tests for colour blindness, test for visual acuity using Snellen's Chart. Exploration of conductive and perceptive deafness by tuning for method.

b) Ergographic recording of muscular fatigue by' Moss's ergograph. Clinical classification of reflexes : superficial reflex - planter reflex, Deep reflex – knee jerk, Visceral reflex - pupillary light reflex.

2. Field Study Report: **4 Marks**

Any one of the followings:

a) Diet survey of a family as per ICMR specification.

b) Population study of physiological parameters such as height, weight, heart-rate, blood pressure, respiratory rate, PFI, TC of RBC, estimation of haemoglobin, DC of WBC as far as practicable.

3. *Viva- Voce:* **5 Marks**

4. Laboratory Note- Book : **3 Marks**

RECOMMENDED TEXT AI\D REFERENCE BOOKS FOR PHYSIOLOGY (GENERAL) COURSE

(The latest edition available should be used for all books)

1. *Human Physiology Vol. 1* & 2, C. C. Chatterjee, Medical Allied Agency.
2. *Sharirbigyan (Bengali) Vol. I* & 2, J. Debnath, Sridhar Prakashani.
3. *Principles of Physiology,* D.Pramanik, Academic Publishers, Kolkata.
4. *Concise Medical Physiology,S.* K. Chaudhuri, New Central Book Agency.
5. *Biochemistry,* D. Das, Academic Publishers.
6. *Paripak, Bipak* 0 *Pusti,* D. Das, Paschim Banga Rajya Pustak Parshad.
7. *Bailey'sText Book of Histology,* W. M. Compenhaver, Williams and Wilkins.
8. *Atlas of Human Histology,* M. S. H Di Fiore, Lea & Febiger.
9. *Essentials of Exercise Physiology,* L.G. Shaver, Surjeet Publications.
10. I .*Text Book of Medical Physiology,* A.C.Guyton, W.B. Saunders Co.
    II. *The Living Body,* O.H Best & N.B Taylor, Williams & Wilkins.
11. *Human Physiology Vol 1* &2, T. K. Basu, Biomed Publications.
12. *Biomedical Instruments and Measurements,* L. Cromwell, FJ Weibell, E.A.Pfaiffer,Prentice-Hall of India Pvt. Ltd.
13. A *Text Book of Practical Physiology,* C.L. Ghai, Jaypee Brothers Medical Publishers Pvt. Ltd.
14. *Medical Physiology,* A.K. Das, Books and Allied (P) Ltd.
15. *Medical Physiology,* A.B. Singha Mahapatra, Current Books International.
16. *Essentials of Medical Physiology:* K. Sembulingam and P. Sembulingam, Jaypee Brothers Medical Publishers Pvt. Ltd.
17. *ImmunoLogy* by D. M. Weir, ELBS.
18. *Park's Text Book of Preventive and Social Medicine* by K. Park, *MIs* Banarsi Bhanot Publishers.
19. *Nutritive Value of Indian Foods* by C. Gopalan and other, NIN, Hyderabad.
20. *Practical Physiology*, by M.K. Manna, Sritara Prakashani, Kolkata
21. Note Books on Practical Biochemistry, Experimental Physiology and Histology (Published by the Physiological Society of India, Kolkata.)

Note: In order to maintain the uniformity of practical knowledge among the students of different Colleges, Physiological Society of India has published Practical Note Books on Physiology comprising syllabi of different Universities, including Calcutta University with the help of experienced teachers of both Honours and General teaching degree colleges. Hence, members of Undergraduate Board of Studies in Physiology recommend the aforesaid Note Books (Experimental, Biochemistry and Histology) for use by the students in undergraduate degree course (General) practical in Physiology.